

DEVELOPMENT OF AND TEACHING RESULTS ON THE SIMPLIFIED TYPEWRITER KEYBOARD

by

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INTRODUCTION

The development of the writing machine, first called a "typewriter" by Pratt¹ in 1867, is one of the successful steps man has made in his struggle to secure easy, objective and fluent means of communication with his fellowmen and for recording his ideas, hopes and attainments. To have described modern typing to an ancient scribe as he chiselled his messages and records in stone or moulded them in clay, or to have dared in the Middle Ages to dream aloud in the presence of a learned sage as he slowly and painstakingly wrote out his ideas with a quill pen, would have been far fetched and perhaps implicated witchcraft. Yet to-day in the United States approximately a million young women are producing many millions of pages of neatly typed correspondence and manuscript with nonchalance and ease that allays any suspicion of magic. That there were in those bygone days dreamers who visioned "machine writing" is evidenced by the fact that in 1714 Henry Mill² obtained a patent for a machine "to impress letters on paper as in writing."³ Conservatism and inertia proved too much for that early invention to overcome and little came of the effort. A number of ambitious individuals, during the first half of the 19th century, tried to design a machine which would produce successful "printed" writing. Their endeavors resulted in crude devices, whose values

¹ Morton, Arthur E. *Questions and Answers on Typewriting and Office Procedure*. Sir Isaac Pitman and Sons, Ltd., London, 1928, p. vi.

² Mares, George Carl. *The History of the Typewriter*. Guilbert Pitman, London, 1909, p. 2.

³ *Ibid.*, Morton, Arthur E., p. 29.

were largely keeping alive an idea which was later to be realized. Out of the fruits and toils of those early years have come many of the fundamental mechanical principles used to-day, such as the movable carriage.

In the late sixties and early seventies a journalist in Milwaukee by the name of Christopher Latham Sholes with some financial assistance from James Densmore, laboriously invented several typewriters. In 1873 he brought forth the earliest commercial typewriter as we know it to-day. It was manufactured by E. Remington and Sons, famous gunmakers, of Ilion, New York. The Sholes' typewriter has gone through various metamorphoses until the "noiseless," "electric" and portable machines are now available. What the future will bring the writers do not know. It is true, however, that the kinship of the Sholes' typewriter to the portable, desk model, noiseless machine of to-day is practically unnoticeable, except for one detail—the keyboard—to which manufacturers and, consequently, operators have consistently clung.

Numerous keyboards have been prepared and patented during the last sixty years, but like a monument to Sholes' genius, the first really workable arrangement has withstood virtually all suggestions for change or improvement. That the present keyboard is awkward and presents difficulties of mastery, conducive to errors, is believed by many, who have analyzed it from the educational point of view.

Many people have thought that the typewriter keyboard should be changed. But how? Hoke,¹ Lessenberry,² Ford,³ Smith,⁴ and White⁵ have studied letter and word errors made by student learners and by fairly proficient typists. Likewise, Rowe⁶ and Morrison⁷ have evaluated errors of technique. Hoke found the letter "E" to be the most used letter in the English language and also the most frequently typed letter error. Lessenberry, in his extensive error

¹ Hoke, Roy E. *The Improvement of Speed and Accuracy in Typewriting*. Johns Hopkins Press, Baltimore, 1922, pp. 20-23.

² Lessenberry, D. D. "Modern Methods of Teaching Typewriting." *Eastern Commercial Teachers' Association Fourth Yearbook*, 1931, p. 149.

³ Ford, Gertrude C. "A Study of Typewriting Errors" (*Common Errors in Typewriting*). Master's Thesis, University of Washington, 1928, pp. 95-98.

⁴ Smith, Harold H. "Problems in Diagnostic Testing and Remedial Teaching as Applied to Typewriting." *Second Yearbook of the Commercial Education Association of New York and Vicinity* (Editor, John V. Walsh), 1932, pp. 53-68.

⁵ White, Walter. *Typing for Accuracy*. H. M. Rowe Publishing Company, Baltimore, 1932, pp. 5, 123.

⁶ Rowe, Clyde. "Correcting Non-Letter Errors in Typewriting." *Journal of Business Education*, Vol. 5, 1931, pp. 30-31.

⁷ Morrison, Noble B. "An Evaluation of Typewriting Errors." *Research Studies in Commercial Education*, Vol. V, E. G. Blackstone, Editor, University of Iowa Studies Monographs in Education, No. 12, Iowa City, 1932, pp. 153-157.

studies, and also White, both found "E" to be the most popular letter error. Smith¹ in his analysis of error studies reveals a range of 92% for accuracy skill on letters. This fact further substantiates the weight of "frequency of use," although there are "other factors" which play an important part, such as the control of the first and second rows. Ford, in search of "Typewriting Demons"^{2,3} found the word "T-h-e" to be most often mis-typed in relation to the Ayres Spelling Scale of the Thousand Most Common Words. This particular research furnished the original inspiration leading to the development of the Dvorak-Dealey Simplified Typewriter Keyboard. Such studies show, first, that there is a commonness about certain errors which is disconcerting to the typist and revealing to any one who will analyze those errors at the typewriter; second, an analysis of letter and word typing errors shows that many of those errors are apparently due to the placement of the letters on the keyboard.

Correct letters in wrong sequences may be typed "T-h-e" or "t-h-d" but never "Q-b-p". "December" may be typed "Decbmber" but not "Decpmber." Letter sequences used with the highest frequency—*th*, *he*, *er*, and *an*—are not typed easily and smoothly by advantageous placements on the old keyboard. It is now quite evident that the Universal⁴ Keyboard was not designed on the basis of knowledge of finger skills and the intricacies of the English language but rather to obviate mechanical difficulties. In fact when Sholes designed the keyboard, such pertinent data were not available had he desired them.

It is obvious that the present keyboard is difficult to operate with all its hurdling. Although Sholes knew that most people were right-handed and that consequently the left hand is usually less efficient and skillful than the right, he did not know the frequency of use for each letter. It is unfortunate that he assigned letters to the left hand which Hoke⁵ found made up 60% and the designers of the Simplified Keyboard found to be 56% of all the letters used in running copy. To the more skillful right hand Sholes assigned letters which

¹ Smith, Harold H. "Problems in Diagnostic Testing and Remedial Teaching as Applied to Typewriting." *Second Yearbook of the Commercial Education Association of New York City and Vicinity* (Editor, John V. Walsh), 1932, pp. 53-68.

² Ford, Gertrude C. "A Study of Typewriting Errors" (*Common Errors in Typewriting*). Master's Thesis, University of Washington, Seattle, 1928, pp. 95-98.

³ Dvorak, August and Ford, Gertrude C. "Typewriting Demons." *Journal of Business Education*, May, 1932, pp. 12-13.

⁴ So termed because not developed according to any known standard (except general usage).

⁵ Hoke, Roy E., *The Improvement of Speed and Accuracy in Typewriting*. Johns Hopkins Press, Baltimore, 1922, pp. 12-33.

Hoke found made up 40% and the present designers found to be 44% of running copy. The left hand in addition has the carriage return although a majority of lines end with letters typed with the left hand. For the right-handed, it is estimated by Hoke that the left hand is given an overload 47% greater than it should have. The finger loads likewise are not proportional to the relative finger strengths or skills. Some fingers are greatly overloaded; others underloaded. Although the second row of keys is generally called the "Home" or "Guide" row, it is assigned only nine letters whose combined frequency of use Hoke found totals only 30% and the present designers found to be 32% of all the letters used in running copy. Likewise, the upper row is given 53% by Hoke and 52% by the present designers and the lower row 17% by Hoke and 16% by the designers of all the letters used in running copy.

Here, then, is a Universal Keyboard designed for a left-handed world, with a home row that is not a home row. Here is a two-handed keyboard on which more than 3,000 words in good usage, because of disregard for the intricacies of the English language, must be typed entirely with the left hand. Many more words are almost typed entirely with the left hand. Similar handicap for the right hand is approximately one-tenth as great. Such words as the following are common one-handed words:

<i>Left Hand</i>	<i>Right Hand</i>
great	jump
saddest	kill
was	minimum
were	you

One need not be surprised, since the present keyboard was not designed specifically to fit the peculiarities of written English, that many common sequences^{1, 2, *} like *ec*, *ce*, *ny*, *un* are stroked by the same finger which must hurdle across the home row from the first to the third row or vice versa. An even greater number of letter sequences like *ed*, *sw*, *ik*, *ol* are stroked by the same finger having to reach from one row to the row above or below, stroking two letters in sequence. See Chart I.

¹ Horn, Ernest, "A Basic Writing Vocabulary." *Monograph in Education*, First Series, No. 4, University of Iowa, 1926.

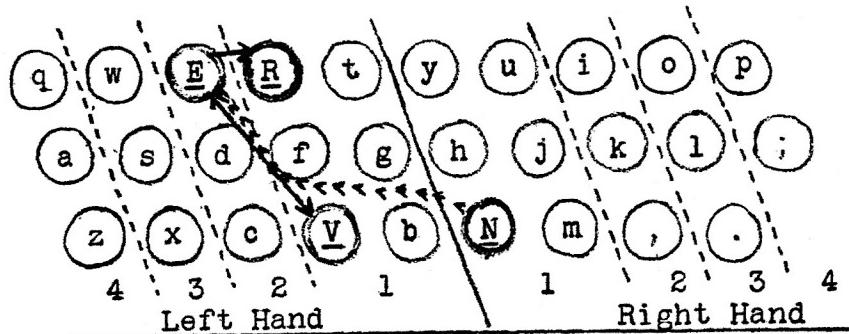
² Rowe, Clyde E. "Importance of Two-, Three-, and Five-Letter Combinations on the Basis of Frequency in a Word List." Master's Thesis, University of Pittsburgh, 1929.

* Lessenberry, D. D., "Modern Methods of Teaching Typewriting." *Eastern Commercial Teachers' Yearbook*, 1931, pp. 148-9.

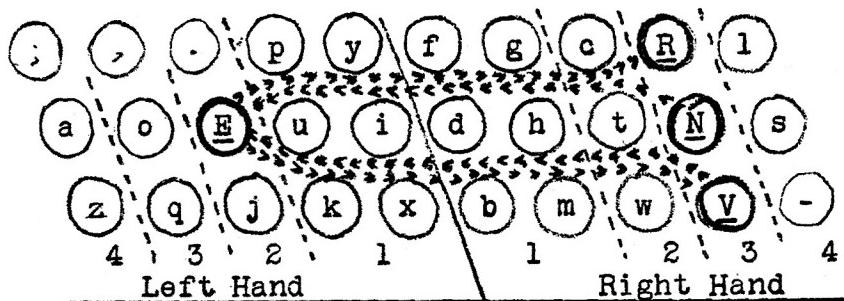
CHART I

Typing Demon: *never.*

Coefficient of Difficulty: 4.49.



Adjacent fingers of the left hand are caught in a repeated wide stretch across the home-row barrier (eve). In fact, the home row runs as a barrier through the entire word.



Play of fingers on opposite hands only. This exchange provides slight, automatic rests which prevent fatigue of the e-finger in its successive strokes.

Such motions temporarily break down the rhythm so essential to rapid accurate typing and which depends in large part on the regular overlapping of successive finger motions. For instance, if a typist by using the fingers of both hands in alternate stroking is typewriting at a rate of 80 words per minute, suddenly comes to a "one-handed" word like "greatest," either the fingers of one hand must speed up to what would be a two-hand rate of 160 words per minute, or else the total typing rate drops temporarily to a 40-word per minute rate. When in addition a one-handed word like "mini-

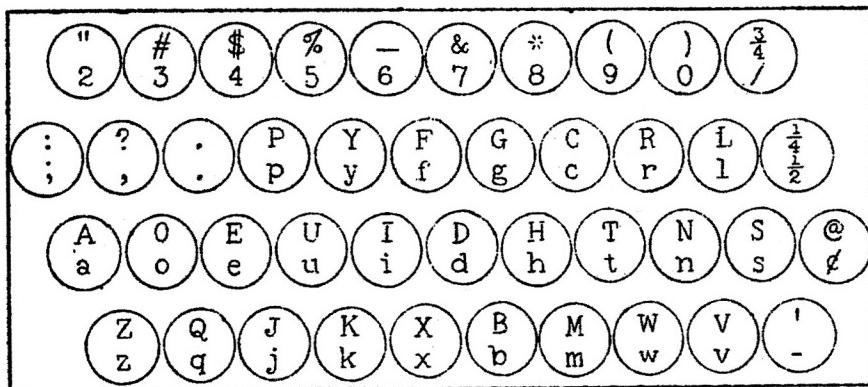
"*num*" involves considerable hurdling of the same finger from the top to the bottom row and back again, the rate drops temporarily to perhaps 20 or 30 words per minute. Instead of being rhythmic most typing is then irregular tapping.

OBJECTIVES

Realizing the faults of the present keyboard, after considerable study of errors previously mentioned as well as the study of frequency of sequences ^{1, 2, 3} Dvorak and Dealey designed and checked against their data dozens of keyboard patterns. The aim was to secure a keyboard pattern which would give to each hand its proportional load, would eliminate awkward stroking, would eliminate one-finger letter sequences and would make for as much alternate use of both hands as possible. The result is the Dvorak-Dealey Simplified Keyboard illustrated in Chart II.

CHART II

SIMPLIFIED TYPEWRITER KEYBOARD



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¹ Horn, Ernest, "A Basic Writing Vocabulary," *Monograph in Education*, First Series, No. 4, University of Iowa, 1926.

² Rowe, Clyde E., "Importance of Two-, Three-, and Five-Letter Combinations on the Basis of Frequency in a Word List," Master's Thesis, University of Pittsburgh, 1929.

³ Lessenberry, D. D., "Modern Methods of Teaching Typewriting," *Eastern Commercial Teachers' Yearbook*, 1931, pp. 148-9.

Accordingly the designers of the Simplified Keyboard worked out the arrangement of the letters in the four-row typewriter keyboard, whereby to the left hand 45% of the stroking in running copy and 55% to the right hand are assigned. The "home row" is a real home row since the letters therein make up 70% of all the letters ordinarily used. When those thousands of words are weighted by the high frequency of such words as

and	is	she
had	not	that
has	one	the

the number of words becomes in excess of 35,000 in every 100,000 running words. The lower row is assigned 8% and the third row 22% of stroking in ordinary copy. Because of the concentration of stroking in the "home row," awkward stroking (same and adjacent finger reaching and hurdling common to the Universal Keyboard) is reduced by 90%.

By placing all the vowels in control of the left hand *no words or syllables* can be typed with the right hand alone. Still the right hand does 55% of all the typing. The consonants z, q, j, k, x, p, and y have such low frequencies of use that, while they combine with the vowels in syllables and even words, they are by virtue of their low frequency of use, of minor importance. Here then is a keyboard which causes the fingers of one hand to stroke alternately with the fingers of the other in 95% or more of the letter sequences. Typewriting on this keyboard should be smoother, faster, less fatiguing, more accurate and more readily learned believe the designers.

PROCEDURES

On the completion of a keyboard arrangement which satisfied the statistical checks and scientific analyses made possible by the data available to the designers, the keyboard was ready for a practical test of its efficiency. This test naturally had to be made with classes of students actually learning to type-write. If the faults attributed to the typewriter keyboard are handicaps to easy and efficient learning of typewriting and if those faults have been largely overcome in the new keyboard, then the superiority of the new arrangement should manifest itself in a practical comparison. The loan of thirty-three Underwood Standard typewriters by the University Bookstore and the University Mimeo Company of Seattle, and a small grant from the University of Washington made possible a practical experiment of the New Keyboard. Mr. Wayne M. Haines, an expert typewriter mechanic, was able to change the type faces and key caps of these machines to make them conform to the designers' plan. Four classes with an approximate total of 90 beginning typists

were conducted for nine weeks at the University of Washington during the Summer Session of 1932. These classes made up of junior high school, senior high school, University students and other adults were taught by two Seattle High School commercial teachers, Mrs. Ruth B. Moore and Miss Viola Goehring. During the fall quarter of the University, there was another class of high school students for nine weeks. In addition, a class of adult students with previous typewriting instruction, was taught to use the new keyboard. The fall quarter teaching was done by Mrs. J. P. Langlow of the University Coaching School, Miss N. L. Merrick, research assistant, and Miss Gertrude C. Ford, research worker, both at the University of Washington. More than a hundred students have learned to typewrite on typewriters equipped with the new keyboard up to January 1, 1933.

In the summer of 1932 it was necessary to use, during the first weeks of instruction, such spontaneously prepared teaching material for acquainting the students with the keyboard as the teachers could prepare from day to day. After the keyboard had been mastered, copy material from typewriter manuals, magazines, books and typewriter company tests was used for developing accuracy and speed. In the fall of 1932 teaching material adapted to the new keyboard, which is soon to appear in the form of a student manual produced by the writers and their colleagues was used. The instruction periods were fifty minutes in length, and with few exceptions because of the scarcity of machines, the instruction periods represented the entire time devoted to practice by the students.

RESULTS

A motion picture analysis and comparison of typewriting on the Universal and the Simplified Keyboards demonstrate simplicity and smoothness of finger motions in using the New Keyboard. The concentration of 70% of the stroking on the home row of the New Keyboard as compared with 32% on the Universal Keyboard in itself does away with much of the finger reaching and hurdling. The choice of locations of the letters in the upper and lower rows and the choice of letters assigned to the fingers of the two hands makes easy on the New Keyboard a majority of the letter sequences which were difficult on the old. What is frequently a difficult second-letter-of-a-sequence stroke of the same finger, becomes on the New Keyboard an initial stroke by a finger of the opposite hand. The finger strokes of one hand alternate with finger strokes of the other hand in "left, right, left right" fashion instead of the "left-right, right, right, right, left, left, left, right, right, right, left, left, left, left, left" fashion often customary on the old keyboard.

Analyses of the "Comparison of Attainments of Students Taught to Type-

write on Machines Equipped with Dvorak-Dealey Simplified Keyboard with Attainments of Students Taught on Universal Typewriter Keyboard" which follow, shows that the beginning experimental classes using the Dvorak-Dealey Simplified Keyboard progressed from two to three times as rapidly in net speed as do students using the Universal Keyboard. Net speeds were attained on "Typewriting Proficiency Tests" published by the various typewriter companies, and scoring was done according to the International Typewriter Contest Rules with the exception that certain types of errors were not counted in the results due to machine handicaps. Most of the tests were either of five or ten minutes in length.

Comparison of Attainments of Students Taught to Typewrite on Machines Equipped
with Dvorak-Dealey Simplified Keyboard with Attainments of Students
Taught on Universal Typewriter Keyboard *

DVORAK-DEALEY SIMPLIFIED KEYBOARD

Classification	Average No. of Fifty-Minute Instruction Periods	Average Attainment †	Gain in Net Words per Minute per In- struction Period
9 High School students	36	40 net words per minute	1.11
12 High School students	38	43 net words per minute	1.13
44 University and adult students ..	26	32 net words per minute	1.23
39 Junior High School students..	24	19 net words per minute	.8
8 Adult students with previous typing experience	29	58 net words per minute	2.00
104 Beginning students	27.5	29.1 net words per minute	1.06

UNIVERSAL KEYBOARD

	No. of Instruc- tion Periods	Average Attainment	Gain in Net Words per Minute per In- struction Period
Usual H. S. requirement for credit	90	18 net words per minute	.20
Average H. S. attainment	90	25 net words per minute	.28
Usual H. S. requirement for credit	180	30 net words per minute	.17
Average H. S. attainment	180	35 net words per minute	.20
Superior H. S. attainment	180	40 net words per minute	.22
Washington State championship record	180	58 net words per minute	.32
Washington State championship record	360	72 net words per minute	.20

* Uhl, W. L. and Dvorak, August, "Drastic Time-Saving and Cost-Economy in Typewriting Classes," *The Nation's Schools* (In press).

† Attainment in net words per minute was measured in accordance with the International Typewriter Contest Rules.

On the Dvorak-Dealey Simplified Keyboard after Varying Portions of a Forty-five Period Course of Instruction

Of 21 high school students	11 reached 40 or more net words per minute
	19 reached H. S. credit attainment for 180 days
	21 reached H. S. credit attainment for 90 days
Of 39 junior high school students....	1 reached 40 or more net words per minute
	5 reached H. S. credit attainment for 180 days
	19 reached H. S. credit attainment for 90 days
Of 44 university and adult students..	10 reached 40 or more net words per minute
	25 reached H. S. credit attainment for 180 days
	36 reached H. S. credit attainment for 90 days

On the Dvorak-Dealey Simplified Keyboard

39 junior H. S. students made an average gain of .8 net words per minute for each period of instruction, or approximately *three to four* times the average gain made by high school students on the Universal Keyboard.

21 high school students made an average gain of 1.12 net words per minute or approximately *four to five* times the average gain made by high school students on the Universal Keyboard.

Students with previous typewriting experience on the Universal Keyboard had little difficulty in changing to the new keyboard as is evidenced by their gain of 2.00 net words per minute per hour of instruction.

An interesting aspect of this experiment is the group of eight adults who were able to typewrite on the Universal Keyboard at rates varying from 30 to 70 net words per minute. Whereas, beginning students progressed in average net speed at approximately an average of one word per minute for every period of instruction, the students with previous typewriting ability on the Universal Keyboard progressed at the average rate of two net words per minute for each period of instruction. On the New Keyboard these typists exceeded their previous net speed on the old keyboard. To date several insist that they will not voluntarily return to the use of the old keyboard. Errors due to confusion of the old and the new keyboards persisted during the first few weeks but disappeared sooner than was expected. One student who previously on the old keyboard had reached what seemed to be her limit—70-75 net words per minute on the usual tests—is now typing around a hundred net words per minute on the same type of tests on the New Keyboard, and believes that she still has not reached the limits of her capacity.

Naturally the New Keyboard should be tried out under normal high school and college classroom conditions. Plans for such practical testing are under way. Typewriter manufacturers now equip and sell typewriters of various models at prices identical with those of similar Universal models when requests for such machines are made at the time the order is placed with the dealer. If the results secured with the experimental classes can be approximated under the usual school conditions, it is evident that in 90 periods of instruction (one semester) high school classes should reach an average attainment of 50 or more